

Considerations for the design of virtual learning environments: a proposal for instructional model based on cognitive functions and didactic strategies

Miguel Ángel Herrera Batista

mherrera@correo.azc.uam.mx

María Dolores González Martínez

mdgm@correo.azc.uam.mx

Universidad Autónoma Metropolitana, Azcapotzalco, México

Abstract: This paper presents an instructional model, developed as part of a research in the Autonomous Metropolitan University, Azcapotzalco, Mexico City. Elements of virtual learning environments and cognitive functions in the learning process supported by didactic strategies are described. Some general characteristics of instructional design are included with our proper approach concerning the basic functions of the new technologies: the provision of sensory stimuli and the cognitive mediation. This model sets out as a guide for the development of virtual learning environments in any educational modality: online, face to face or blended, and could be applied to different disciplines. The paper focuses on the interface as fundamental element to integrate the aspects of the instructional design in virtual learning environments.

Learning environments

A learning environment is a place where students and teachers come together to interact psychologically in relationship to certain contents, by means of previously established methods, skills and didactic strategies with the purpose of acquiring knowledge, developing skills and attitudes and increasing some type of capability or performance. "A learning environment is a place where people can look for resources to give sense to ideas and to construct significant solutions for the problems." González and Flores (2000). A learning environment not only refers to a physical context and material resources. It also implies psychological aspects that are extremely important in the success or the failure of educational projects.

Virtuality in the learning environments

Virtual learning environments are computer digital and immaterial environments that provide the conditions for carrying out activities of learning and can be used in any educational modality: face to face, online, or blended. As Skagestad (2006) explains, the concept of virtuality understood as cultural phenomena have two different approaches: functional equivalence or equivalent appearance. We take both approaches to affirm that in a virtual learning environment the students should feel and perceive the function as if they were inside a classroom.

We can distinguish two types of elements in a virtual learning environment: the constitutive ones and the conceptual ones. The first are means of interaction or communication processes between subjects, resources, spaces where the activities are carried out, and psychological factors; the last are aspects that define the educational approach of the virtual environment such as the instructional design and the interface design.

Constitutive elements in virtual learning environments

Whereas the interaction in face-to-face learning environments is predominantly oral, the interaction in online environments occurs, nowadays, in a predominantly written manner. It can be made in synchronous or asynchronous way. The interchange of ideas can be multidirectional, as a dialogue, where the information flows in two or more directions, through e-mail, threaded discussions, distribution lists, etc., or can be unidirectional, where the information only flows in a sender-receiver path mainly through decoding or reading materials. Although an indirect dialogue with the author is established, a direct contact with him or her may not occur. (Fainholc, 1999). The resources in traditional learning environments are usually printed (texts) or written (messages or notes on the board); in virtual environments the resources are in digital format (text, images, hypertext or multimedia). In both type of

resources, it is possible to count with additional supports like newspaper archives, traditional or virtual libraries, web sites, electronic books, etc. The physical environmental factors in the premises such as lighting, ventilation, disposition of the furniture, etc., are very important in the face-to-face education but in virtual learning environments, the effective control can escape from the institutions or the staff. That type of physical resources keep on being important but they depend mostly on the possibilities of the students or on the support who could receive from the institution. Multimedia resources can help to make virtual learning environments more comfortable after stimulates the senses by means of music or images that make available favorable conditions. Finally, the computer can mediate the psychological relationships. New technologies serve as the cognitive mediator between the mental structures of the subjects and the resources.

Conceptual elements of the virtual learning environments

There are two elements: instructional design and interface design. The instructional design refers to the manner in which the educational act is planned. It includes objectives definition, design of activities, planning of strategies and didactic skills. In addition, evaluation and feedback are some of his elements, depending on the instructional model adopted. The interface design refers to the visual and formal expression of the virtual environment. Interface is the digital space in which the participants have to meet. The visual characteristics of usability and navigation are determinant for a suitable operation of the instructional model.

Cognitive functions in the learning process

The new technologies in education have been used as a way of delivering information. Nevertheless, we believe that they can develop other equally important functions. Herrera (2004) proposes two basic functions of the new technologies related to the generation of learning which explains how acquire knowledge: the provision of sensory stimuli and the cognitive mediation. The first one, the provision of sensory stimuli, is the capability to stimulate the human manifested through the interface that displays information as images, texts, sounds, etc. One should be careful that the participants accurately receive the messages. The provision of stimuli has, at least, two dimensions that we must consider in the design of virtual learning environments: the attentional dimension refers to the potentiality that the interface has to center the attention of the students on the outstanding stimuli or to inhibit the noises and interferences of the environment. The motivational dimension refers to the potentiality of the interface to encourage the enthusiasm of the students towards learning. The second one, the cognitive mediation refers to the transit of ideas across the mental structures of the educational act subjects. It is necessary to understand how the cognitive schemes interact to be modified. This mediation not only happens across the dialogue supported between two or more individuals where the bidirectional interaction is possible (in the e-mail, for example). It also happens between the students and the author of a text (printed or digitized), even if the interaction is unidirectional. In the process of reading, the students get in touch with the cognitive schemes of the author. This cognitive mediation is also possible between the students and the "reality" by means of a virtual representation.

Didactic strategies and instructional means

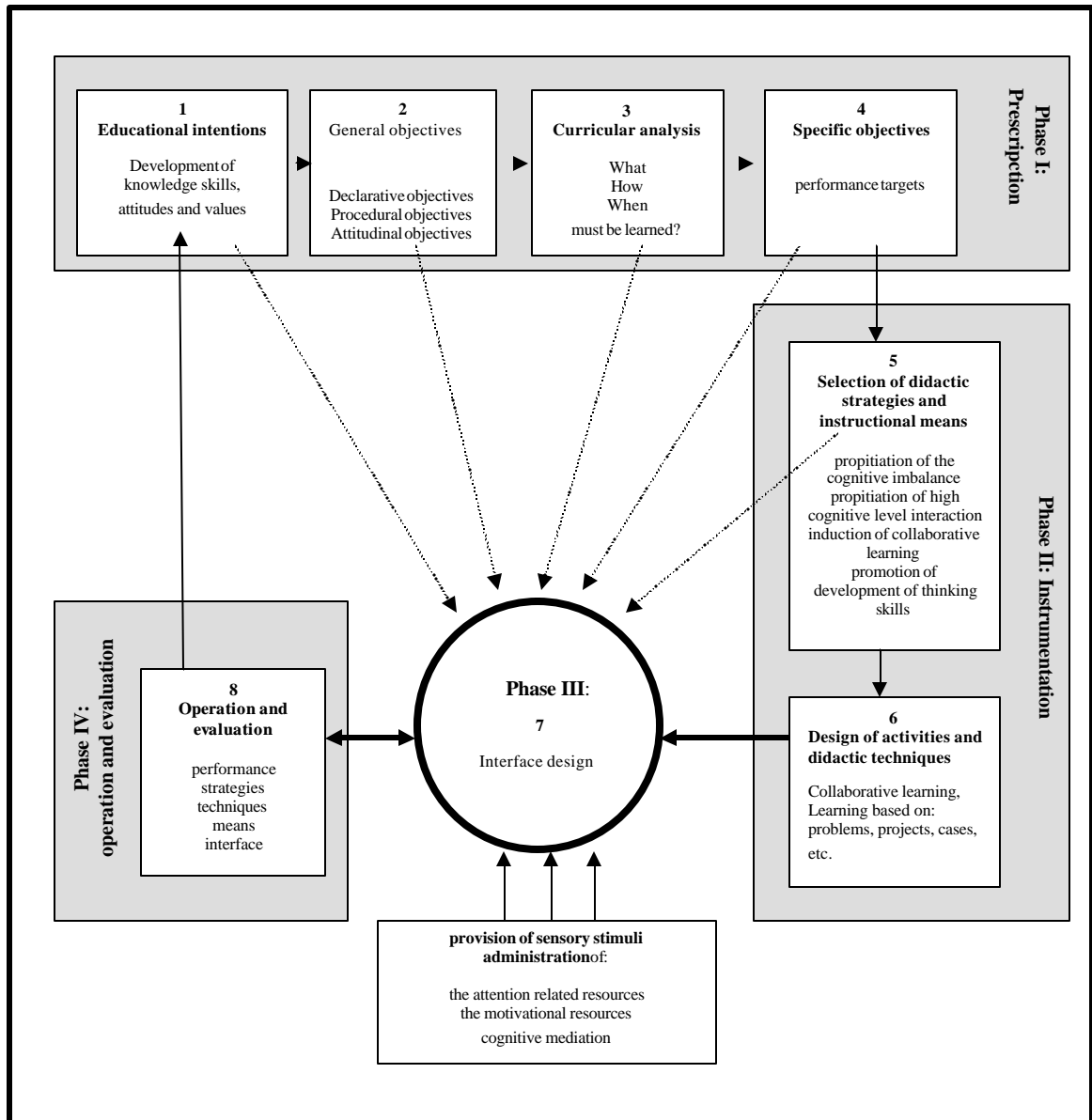
The use of didactic strategies and suitable instructional means are fundamental in instructional design. We propose six didactic strategies sustained in the analysis of the contributions of Piaget (Atherton, 2005), and Vygotsky that deal with regarding the genesis of knowledge, with the critical approach of didactics, the role of the information and communication technologies and interface design.

- The propitiation of the cognitive imbalance is a necessary condition to prepare the students for the processes of accommodation and assimilation.
- The propitiation of the interaction of high cognitive level stimulates that the students could confront, at least two different cognitive structures.
- The induction of collaborative learning motivates the establishment of necessary conditions such as positive interdependence, face to face encouraging interaction, individual responsibility, interpersonal skills and team work, (Johnson, 1995).
- The promotion of development of thinking skills is a necessary condition to favor the quality of learning and to provide metacognitive resources.

- The administration of the attention related resources. Student's attention is a limited resource so it is necessary to administer it appropriately.
- The administration of the motivational resources must be made properly in order to induce the student to maintain its attention instead of causing distraction.

Phases and stages of the instructional model

This model consists of four general phases that are constituted in turn by several stages. These are shown in the following figure:



Phase I: prescription

We describe beforehand the expected results from the instructional process. It consists of four stages:

1. Educational intentions. The essential target of any educational project is the integral development of people. In this stage, the question is what type of persons is desirable to develop? From this position, it is assumed that besides the acquisition of knowledge, one must promote the development of skills, attitudes, and values. As Delors (1996) mentions, the education challenges in the XXI century are learn to know, learn to do, learn to live together and learn to be.

2. General objectives. According to the planned educational intentions, these objectives could be established in one of three types:

- declarative objectives that will be focused on the contents,
- procedural objectives to emphasize skill development,
- attitudinal objectives to guide the acquisition of attitudes and values.

3. Curricular analysis. We found three fundamental sources for the development of study plans and programs, or formal curriculum. First, the sociocultural source determines the needs and requests that the society expect from education. The second one, the psycho-pedagogic source establishes the characteristics of the process of learning taking in account the individual differences and the cognitive styles of the students. The third, the epistemological source corresponds to the nature itself of the area of the content that is the object of the academic program. In agreement with Stenhose (1984), we propose to respond the following questions for planning a course:

- What must be learned and be taught in this course or program? That is to say: what knowledge, attitudes and values must be acquired or be developed by the students in the course?. What is it expected from students after they have finished the course? What skills and knowledge must the students have to continue with the program? What type of values and attitudes does the society expect from graduates of the educational program?
- How the contents of the course must be learned and be taught? That is to say: what is the ideal sequence of the contents?, which are the desirable strategies, activities and didactic resources for a suitable learning?, which is the level of previous knowledge that the students have?, what cognitive styles do characterize the students?
- When the contents of the course must be learned and be taught? That is to say, in accordance with the academic program and with the intellectual development of the students, when is it the best moment for learning the contents?

4. Specific objectives. We have to choose specific performance targets if we want to make more efficient the educational practice. This allows a better learning planning. Performance objectives are constituted of five elements:

- The situation
- The capacity to be acquired
- The learning object
- An observable action
- The conditions of performance

Phase II: instrumentation

It refers to the activities and means that shape up and materialize instruction. It consists of two stages:

5. Selection of didactic strategies and instructional techniques. They correspond to our position in relationship to five aspects: generation of learning, cognitive mediation between information and communication technologies, the role of the new technologies, the provision of sensorial stimuli, and the critical approach of didactics.

There is not a single relationship between techniques and didactic strategies. In fact, many techniques can respond to two or more strategies. For example, the technique known as learning based in problem solving, can serve to propitiate the cognitive imbalance (strategy 1), the interaction of high level between the members of the learning community (strategy 2) and to promote the critical thought (strategy 3). It is not important that the same

techniques serves for diverse strategies, instead we could decide the manner they can approach a planned and suitable way.

Although it is desirable to implement different strategies, it is difficult that in all the activities or in all the contents we could apply all of them in a joint way. One of them will have to be selected for each case. The application of the strategies must be systematical and pertinent so they could offer the expected results. According to these strategies, the instructional project is developed as a whole and it orients the design of the activities and the selection of the didactic techniques. In this phase, also the computational resources are taken into account.

6. Design of activities and didactic techniques. In this stage is necessary that the students always conduct significant cognitive actions providing new information. For example, when the students make a comparative analysis between two readings as an assignment, the cognitive process is more complex than summarize or transcribe. Since time is a limited resource, it is advisable to establish clearly the terms and the conditions for the activities accomplishment. Collaborative activities usually require more time when you are working online.

Strategies	Suggested activities
To propitiate the cognitive imbalance in order to prepare students for the processes of accommodation and assimilation.	To create conditions of challenge for the student in which situations of contrast be exposed. We can use techniques like debate, dramatization, readings of authors with opposite foci on a same theme, to present information that challenge the common sense, to utilize the technique of the question, etc
To propitiate the interaction of high cognitive level stimulates that the students could confront, at least two different cognitive structures.	To present activities that compromise and support personal opinions offering opportune feedback.
To induce collaborative learning motivates the establishment of necessary conditions such as positive interdependence, face-to-face encouraging interaction, individual responsibility, interpersonal skills and team work.	To establish common objectives where the benefit of the group is joined to the individual benefit and not the one without the other is conceived. The technique of the learning based on projects can be utilized.
To promote development in students thinking skills with specific programs of self-learning.	To design activities that imply the development of basic abilities as the observation, relation, comparison, deductive-inductive reasoning, as well as other abilities like problem solving, creativity development, etc.

Phase III: interface design

It is the production of the set of images, texts and other elements, which students will see in the computer's monitor. As it is observed in the figure, the interface design is considered the center of all the phases, where cognitive functions and didactic strategies are integrated as visual elements to conform the virtual environment. This is a key stage in the model since it is where the provision of sensorial stimuli is arranged, that is one of the basic functions of the new technologies and the paths of interaction for the cognitive mediation outline here. The provision of sensory stimuli is given when the computer, through the interface, serves as the mediator among the subject and the sources of information.

In this stage, the role played by Design as a discipline is crucial since its mission is to give support to the visual communication. To facilitate the implementation of the six proposed strategies and to foresee his operation capability it is important to be careful with the use of animations and other visual and audio resources. The abuse of these elements can create the opposite effect by distracting students' attention and motivation instead of concentrating the attention and supporting the motivation of the students. Other significant aspects that should be attended in this phase are the concepts of usability (facility of use), navigability (facility on transiting through the pages of a website), and ergonomics (use of colors, forms, textures and typography that allow a suitable comprehension).

Phase IV: operation and evaluation

These actions, made simultaneously throughout all the process, as well as the feedback. They evaluate the students' performance, the strategies, the means, and the interface, in order to improve continuously.

Conclusions

Today, we can offer the students the best educational tools incorporating the new technologies in learning environments. New technologies can contribute to improve learning independently of the modality of education, face to face or e-learn. Its use is a valuable resource and it is a right for all the students in the world. Nevertheless, this is not given in an automatic way; it is required an instructional design supported in education cognitive theories. Learning takes place in the mind of students, not in the circuits of a computer. Our model reveals the importance of the interface design, considered as the central element that values the role of the graphic designers in developing these educational spaces.

Our instructional proposal propitiates learning through didactic activities. This type of activities permits the students to develop thinking skills as they confront their own cognitive structures with other mental structures in the processes of cognitive mediation promoted by those activities. Therefore, the students process the information and they can build their own knowledge.

Once we have completed the model, the next step will be to validate it by means of an experimental process. We believe it will produce excellent results because it combines the use of technology and instructional means that help to change attitudes of faculty and students.

References

- Atherton, J. S. (2005). *Learning and Teaching: Assimilation and Accommodation* [On-line] UK: Available: <http://www.learningandteaching.info/learning/assimacc.htm>. Accessed: 22 April 2006
- Bonk, C. J. (2002). *Online training in an online world*. Bloomington, IN:CourseShare.com.
- Bricall, J. (2000). *Universidad 2000*. Ed. CRUE, Madrid.
- Buitrón, M. (2003). “*Consideraciones para el diseño de interfaces gráficas de usuario en ambientes virtuales educativos*”. Tesis para optar por el grado de Maestra en Diseño en la Línea de Nuevas Tecnologías. México. Universidad Autónoma Metropolitana, Azcapotzalco.
- Cabero, J., Salinas, J., Duarte, A., Domingo, J. (2000). *Nuevas tecnologías aplicadas a la educación*. Madrid. Ed. Síntesis.
- Castañeda, S., López, M., (1993). *Manual para el curso de Psicología de la Educación*. México. Ed. ITESM.
- Fainholc, B., (1999). *La interactividad en la educación a distancia*. Argentina. Ed. Paidós.
- Gronlund, N. E. (2000). *How to write and use instructional objectives*. New Jersey. Ed. Upper Saddle River.
- González, O., Flores, M., (2000). *El trabajo docente: enfoques innovadores para el diseño de un curso*. Ed.Trillas, México.
- Herrera, B. Miguel (2001). “*Las fuentes del aprendizaje en ambientes virtuales educativos*”. Revista Iberoamericana de Educación, 25 - 10–01. ISSN:1681-5653, [On-line] <http://www.campus-oei.org/revista/deloslectores/352Herrera.PDF>, Accessed: 18 March 2006.
- Herrera, B. Miguel. (2004). “*Las Nuevas Tecnologías en el aprendizaje constructivo*.” Revista Iberoamericana de Educación, Número 34/4. ISSN:1681-5653, [On-line] http://www.rieoei.org/tec_edu29.htm, Accessed:12 April 2006.
- Jonassen, D., Peck, K., Wilson, B. (1999). *Learning with technology: A Constructivist Perspective*. New Jersey. Ed. Prentice Hall.
- Kirkpatrick, D. (1995). *Evaluating training programs*. Ed. Berrett-Koehler, San Francisco.
- Mergel, B. (2003). “*Diseño instruccional y teoría del aprendizaje*”. [On-line] Accessed:3 May 2005 <http://www.usask.ca/education/coursework/802papers/mergel/espanol.pdf>
- Mayer, R., (1987). *Educational Psychology. A cognitive approach*. Boston. Ed. Little, Brown and Co.
- Piskurich, G. (2000). *Rapid instructional design: Learning ID fast and right*. U.S.A. Ed. Jossey-Bass, Pfeiffer.
- Rothwell, W. and Cookson, P. S. (1997). *Beyond instruction: Comprehensive program planning for business and education*. San Francisco. Ed. Jossey-Bass.
- Stenhouse, L., (1984). *Investigación y desarrollo del currículo*. Madrid. Ed. Morata.